

WHAT IS CLAIMED IS:

1. A soil amendment composition comprising an insoluble hydratable keratin or an insoluble keratin hydrogel, wherein said hydratable keratin or keratin hydrogel is associated with one or more cationic species.

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2. The soil amendment of claim 1, wherein said hydratable keratin or keratin hydrogel comprises sulfonate groups.

10 3. The soil amendment composition of claim 1, wherein said keratin is derived from a source selected from the group consisting of hair, feathers, leather, nail, skin, hooves, fur, beaks, claws and scales.

4. The soil amendment composition of claim 1, wherein said one or more cationic species comprise one or more metal ion species

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5. The soil amendment composition of claim 4, wherein said one or more metal ion species are selected from the group consisting of potassium, sodium, copper, zinc, manganese, magnesium and calcium.

20 6. The soil amendment of composition of claim 1, further comprising a preservative.

7. The soil amendment of composition of claim 6, wherein said preservative is a tetraalkylammonium hydroxide.

8. A soil amendment composition comprising an insoluble keratin hydrogel or an insoluble hydratable keratin, wherein said keratin hydrogel or hydratable keratin is derived from hair, includes sulfonate groups and is associated with a plurality of metal ion species.

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9. The soil amendment composition of claim 8, wherein said plurality of metal ion species are selected from the group consisting of potassium, sodium, copper, zinc, manganese, magnesium and calcium.

10 10. The soil amendment of composition of claim 8, further comprising a preservative.

11. The soil amendment of composition of claim 10, wherein said preservative is a tetraalkylammonium hydroxide.

15 12. A soil amendment composition comprising an insoluble oxidized hydratable keratin made by the process comprising:

(a) oxidizing disulfide bonds in a keratin material with an oxidizing agent to obtain an oxidized keratin solid having sulfonic acid residues;

20 (b) contacting said oxidized keratin solid with a neutral or slightly alkaline water-miscible solvent containing one or metal ion species, such that said one or more metal ion species are associated with said oxidized keratin solid; and

(c) substantially removing said water-miscible solvent to obtain an oxidized hydratable keratin.

13. The soil amendment composition of claim 12, further comprising hydrating said oxidized hydratable keratin to obtain an oxidized keratin hydrogel.

14. The soil amendment composition of claim 12, wherein said neutral or slightly alkaline water-miscible solvent comprises up to about 20 volume percent water.

15. The soil amendment composition of claim 12, wherein said keratin material is derived from a source selected from the group consisting of hair, feathers, leather, nail, skin, hooves, fur, beaks, claws and scales.

16. The soil amendment composition of claim 12, wherein said one or more metal ion species are selected from the group consisting of potassium, sodium, copper, zinc, manganese, magnesium and scales.

17. The soil amendment composition of claim 12, wherein said oxidizing agent is selected from the group consisting of hydrogen peroxide, alkali peroxides, peracids, perborates, percarbonates, persulfates, hypochlorite and chlorine dioxide.

18. The soil amendment composition of claim 12, wherein said water-miscible solvent is a lower alkyl alcohol selected from the group consisting of methanol, ethanol, isopropanol, n-propanol, t-butanol and combinations thereof.

19. A process for making an insoluble hydratable keratin-derived soil amendment material comprising the steps:

(a) oxidizing a keratin material in a first solution with an oxidizing agent such that a portion of the disulfide bonds of said keratin material are oxidized to form sulfonate groups, to form an oxidized keratin solid fraction;

(b) separating said oxidized keratin solid fraction from said first solution;

(c) contacting said oxidized keratin fraction with a second solution comprising one or more metal ion species, dissolved in a neutral or slightly alkaline water-miscible solvent;

(d) maintaining said second solution containing said oxidized keratin fraction and said one or more metal ion species for a time and temperature effective to cause an association between said oxidized keratin and said one or more metal ion species; and

(e) substantially removing the solvent from said oxidized keratin fraction associated with said one or more cationic species to obtain a hydratable keratin material.

20. The process of claim 19, further comprising hydration of said hydratable keratin material to form a keratin hydrogel.

21. The process of claim 19, wherein said neutral or slightly alkaline water-miscible solvent comprises up to about 20 volume percent water

22. The process of claim 19, wherein said keratin material is derived from a source selected from the group consisting of hair, feathers, leather, horn, nail, skin, hooves, fur, beaks, claws and scales.

23. The process of claim 19, wherein said oxidizing agent is selected from the group consisting of hydrogen peroxide, alkali peroxides, peracids, perborates, percarbonates, and persulfates, hypochlorite and chlorine dioxide.

5 24. The process of claim 19, wherein said water soluble solvent is a lower alkyl alcohols selected from the group consisting of methanol, ethanol, n-propanol, isopropanol, t-butanol and combinations thereof.

10 25. The process of claim 19, wherein said one or more metal ion species are selected from the group consisting of potassium, sodium, copper, zinc, manganese, magnesium and calcium.

26. A method for increasing the water retention properties of soil, comprising addition to soil of an insoluble hydratable keratin material.

15 27. The method of claim 26, wherein said hydratable keratin material comprises sulfonate groups and is associated with one or more metal ion species.

28. The method of claim 26, wherein said hydratable keratin material is hydrated to form a hydrogel.

20 29. The method of claim 28, wherein said hydrogel is added to soil at an amount between about 1% by weight to about 25% by weight.

30. The method of claim 28, wherein said hydrogel is added to soil at amount between about 1% by weight to about 5% by weight.

5 31. The method of claim 26, wherein said hydratable keratin material provides nitrogen to said soil.

32. A method for providing trace metal nutrients to soil comprising addition to soil of an insoluble hydratable keratin material, wherein said keratin material is associated with a plurality of metal ion species.

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33. The method of claim 32, wherein said keratin material comprises sulfonate groups.

34. The method of claim 32, wherein said plurality of metal ion species are selected from the group consisting of potassium, sodium, copper, zinc, manganese, magnesium and calcium.

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35. The method of claim 32, wherein said hydratable keratin material is hydrated to form a hydrogel.

20 36. The method of claim 32, wherein said hydratable keratin material provides nitrogen to said soil.

37. A method for the bioremediation of soil comprising addition to soil of an insoluble hydratable keratin material, such that said hydratable keratin material provides a nutrient source for microorganisms capable of remediating soil contaminated with environmental toxins.

5 38. The method of claim 37, wherein said keratin material comprises sulfonate groups and is associated with one or more metal ion species.

39. The method of claim 37, wherein said hydratable keratin material is hydrated to form a hydrogel.

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40. A method for the bioremediation of water contaminated with environmental toxins comprising contacting an insoluble hydratable keratin material with said contaminated water, wherein said keratin provides a nutrient source for microorganisms capable of remediating said water contaminated with environmental toxins.

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41. The method of claim 40, wherein said water is groundwater.

42. The method of claim 40, wherein said water is surface-water.

20 43. The method of claim 40, wherein said hydratable keratin material comprises sulfonate groups and is associated with one or more metal ion species.

44. A method for reducing the migration of environmental toxins in soil comprising addition to soil of an insoluble hydratable keratin material wherein said environmental toxins are adsorbed by said keratin material.

5 45. The method of claim 44, wherein said hydratable keratin material comprises sulfonate groups and is associated with one or more metal ions species.

46. The method of claim 44, wherein said hydratable keratin material provides a nutrient source for microorganisms capable of remediating soil contaminated with environmental toxins.

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47. A method for reducing the migration of environmental toxins in groundwater comprising contacting a permeable barrier comprising an insoluble hydratable keratin material with a plume of said environmental toxins in groundwater.

15 48. The method of claim 47, wherein said keratin material comprises sulfonate groups and is associated with one or more metal ion species.

49. The method of claim 47, wherein said keratin material adsorbs said environmental toxins.

20 50. The method of claim 47, wherein said environmental toxins bind ionically to said keratin.

51. The method of claim 47, wherein said hydratable keratin material provides a nutrient source for microorganisms capable of remediating groundwater contaminated with environmental toxins.